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ABSTRACT

The context of learning with computers is different from that of more traditional educational media because the computer is a new medium whose interactivity supports dynamic, evident, and malleable representations of abstract ideas. The model proposed addresses some mediating factors of the environment in which computers are used that affect learners' cognitive processes. The thesis is based on work conducted by a research group on large scale computer-based instructional systems to teach basic skills, instructional design for teaching computer implementations, and teaching problem solving using Logo. It is noted that: (1) programs are improved when they are structured to utilize other media in addition to computers; (2) computer training materials should support inferential learning; and (3) within computer environments, mediated learning approaches are more effective methodologies than either strict instruction or discovery-oriented approaches. (14 references) (Author/DB)

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PLACING COMPUTER LEARNING IN CONTEXT

by

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PLACING COMPUTER LEARNING IN CONTEXT

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ABSTRACT

The context of learning with computers is different from that of more traditional educational media because the computer is a new medium whose interactivity supports dynamic, inspectable, and malleable representations of abstract ideas. The model we propose addresses some mediating factors of the environment in which computers are used that effect learners' cognitive processes. Our theses is based on work conducted by our research group on large scale computer based instructional systems to teach basic skills, instructional design for teaching computer implementations, and teaching problem solving using Logo. We believe; 1) that programs are improved when they are structured to utilize other media in addition to computers, 2) that computer training materials should support inferential learning, and 3) that within computer environments, mediated learning approaches are more effective methodologies than either strict instruction or discovery-orientedapproaches.

INTRODUCTION

The use of computers in schools is increasing at a tremendous rate. In the United States, for example, the number of computers in schools has doubled since 1985 to 2.25 million, or one computer for every 20 students. Educational computing, however, has not achieved anything near what many contend this new medium might deliver (ref 1). We offer one reason; that the importance of the context within which computer-based learning takes place has too long been overlooked. The benefits the computing medium affords will only be maximized when the context, the educational environments, incorporate settings, materials, and interpersonal relationships which in turn support interactive learning. The computer is a new medium whose interactivity supports dynamic, inspectable, and malleable representations of abstract ideas. Media are artifacts of thought which extend and alter the structures of our thinking (ref 2). We have seen a progression from orality to text as the basis for thought and learning. Educational methods and materials have undergone corresponding changes. We therefore have a great deal of experience, hence expertise, using text-based and graphical materials, but we have very little experience and nothing approaching expertise concerning the educational uses of interactive media. This paper addresses these issues based on the findings of our research. These findings support contexts which take into account mediating learning environments which enable students to build cognitive structures that relate to the dynamic logical structures of computers.

SUPPORTIVE RESEARCH

Taylor (ref 3) informs us that computers are used educationally in three forms: as tutors to teach users some content or skill area; as tools to enhance users' productivity; and as tutees that users program to explore and develop their own thinking and learning processes. Our findings are taken from each of these areas: from studies of basic skills remediation using computer based instruction (CBI); from instructional design research for learning computer applications; and from studies concerned with the development of problem solving through computerprogramming.

Research conducted within New York City's Computer Pilot Program for the Office of Research, Evaluation and Assessment (ref 4) analyzed achievement in 31 schools using integrated CBI systems to improve the basic reading and mathematics skills of educationally disadvantaged students. Among other things, we assessed implementation

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factors influencing program effectiveness as measured by increases on standardized achievement tests. We found that five of the six most effective program implementations were located in settings other than computer labs -- resource rooms, regular classrooms, school libraries, students' homes. We also found that program implementations involving two 45-minute on-line sessions per week (and three regular classroom sessions) were more effective than implementations involving either more or less time spent using computers, and that implementations employing student/staff ratios of 15/1 were more effective than implementations with either larger or smaller student/staff ratios.

Research on developing training materials to teach computer applications conducted at Teachers College, Columbia University (ref 5-7) indicates that people learn to use computer applications most effectively when the instructional materials utilized are based on the minimal manual approach (ref 8) and designed to be inferential. Inferential materials are those which present information which requires that students infer the actions they must take in order to operate the program, thereby developing a cognitive relationship between both the manual and the computer. In this way, students construct for themselves a schema of the workings of the application. Our research has shown that this approach enables them to learn the material presented, to better learn new material not presented during training, and to negotiate the relationship between the training materials and the computer which then enables learners to trouble-shoot problems as they arise.

Research on Logo programming and the teaching and learning of problem solving (ref 9-10) was conducted in a variety of settings with over 300 students ranging in age and ability from elementary through graduate school. Our findings show that computer programming practice can indeed support the development of five particular problem solving strategies, but only when such strategies are explicitly taught, and practiced in mediated programming environments. Mediated environments are settings in which teachers support a gradual development of student independence through modeling and coaching. Other research in this area (ref 11-14) also suggests that mediated learning is an important factor in successful programming/problem solving interventions. Our findings concerning ideal student/staff ratios in the Computer Pilot Program (ref 4) likewise support the efficacy of mediated learning in computing environments, in that a 15/1 student/staff ratio allows teachers to give students needed attention but not without those students having to begin to problems out for themselves.

We believe that taken as a whole, our findings on learning from, about, and on computers suggest that such learning will be most successful when the context in which it takes place mirrors the interactivity of the computing environment itself. The research on CBI, for example, suggests that physical settings which integrate computer-based material with material presented via other media (either through location in non-traditional settings or through lessons conducted both on and off computers) are more supportive of student learning than more homogeneous settings. The research on applications training suggests that materials which require students to infer relationships within programs through interaction with the computer are more supportive of student learning than materials which do not require such inference. The research on programming and problem solving suggests that pedagogies which involve student/teacher interaction within the problem solving process are more supportive of student learning than more traditional pedagogies.

CONCLUSIONS

The contextual issues addressed here are based on our research on educational computing in the areas of CBI, applications training, and programming to teach problem solving. Our findings are therefore limited to these particular areas. None the less, it is important to begin to understand that computers are different from more traditional instructional media and that the context of their use should differ accordingly. One important way in which computers differ from other media is that they are interactive. Not surprisingly, our research suggests that contexts which enhance the computer's interactivity are more

conducive to computer-based learning than contexts geared to more traditional media. Specifically, we have found:

1. that programs which are structured to take advantage of other media in addition to computers are more effective than programs involving computers alone, most likely because such usage is a mediating factor that facilitates the cognitive activity of generalization and transfer;

2. that computer training materials which support inferential learning are more effective than materials which simply tell learner what to do, most likely because such materials can coach learners toward cognitive processes which foster the development of a schema of the computer implementation;and

3. that within computer environments, teacher supported mediated learning approaches are more effective methodologies than either strict instruction or discovery-oriented approaches, most likely because such approaches model cognitive processes too complex for learners to discover on their own, but which such learners non-the-less need to practice in order to become proficient.

In all three cases, interactive learning methodologies were more effective than more traditional ones. We believe this is because traditional methodologies and the context in which they are found are geared to traditional (static) media, and that the interactive medium of computing requires a context which supports more interactive techniques.

Our memories are filled interesting people we have met, places we have been, and things we have seen. At the simplest level, we are proposing a model of learning from and about computers which suggests that the most effective uses of the people, places, and things that make up the context in which such learning takes place will be those which best match the interactivity found on computers themselves. We believe that the external contexts best suited to learning with the interactive media that computers represent will be those that help bridge the gap between learners' internal cognitive environments on the one hand, and the internal logical environments of computers on the other.

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